PacRim Coal

Chuitna Coal Project

Section 106 Report

Addendum

Radiocarbon Dating Results

2006 Field Season

Prepared for

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26 March 2007

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LIST OF ACRONYMS AND ABBREVIATIONS

ADNR	Alaska Department of Natural Resources
AHRS	Alaska Heritage Resources Survey
AMS	Accelerator Mass Spectrometry
APE	Area of Potential Effects
BP	Before Present (years before 1950)
^{14}C	Carbon 14
CCP	Chuitna Coal Project
EPA	Environmental Protection Agency
GPS	Global Positioning System
HAF	Housing and Airstrip Facility
LLD	Ladd Landing Development
M.A.	Master of Arts
NRHP	National Register of Historic Places
OHA	Office of History and Archaeology
SD	Standard Deviation(s)
SHPO	State Historic Preservation Office(r)
SRB&A	Stephen R. Braund & Associates
U.S.	United States

INTRODUCTION

DRven Corporation contracted with Stephen R. Braund & Associates (SRB&A) in October of 2005 to conduct a review and evaluation of previous cultural resources research done for various components of the proposed Chuitna Coal Project (CCP) on the west side of Cook Inlet (Figure 1). SRB&A conducted cultural resources field surveys of these project components of the CCP between May and October of 2006. A discussion of these surveys and their results, as well as SRB&A's recommendations for an archaeological district, is included in a previously submitted report (SRB&A 2006). During the course of intensive survey in the Ladd Landing Development (LLD) area, SRB&A documented 48 house pits in 16 clusters (TYO-00114 through TYO-00129 inclusive; Figure 2) and 377 pits of various sizes. SRB&A (2006) recommended that these features be found eligible for the National Register of Historic Places (NRHP) as an archaeological district, the proposed *Ch'u'itnu* Archaeological District (TYO-00132), under Criterion D (information potential). As construction of facilities in the LLD area could destroy house and cache pits, removing their potential to provide information, SRB&A recommended a finding of "Historic properties affected" (36 CFR Part 800.4(d)(2)) for the LLD because the undertaking will directly or indirectly alter one or more of the characteristics of the *Ch'u'itnu* Archaeological District that qualify the district for inclusion for the NRHP in a manner that would diminish the integrity of the district's design, setting, feeling, workmanship, and association (36 CFR Part 800.5(a)(1)). In a letter from the State Historic Preservation Office (SHPO) to the Environmental Protection Agency (EPA), SHPO concurred with EPA's finding that the *Ch'u'itnu* Archaeological District (TYO-00132) is eligible for the NRHP under Criterion D and that TYO-0014 through TYO-00129 are eligible as contributing properties to the district as well as EPA's finding of "Historic properties affected" (36 CFR Part 800.4(d)(2)) for the LLD (SHPO 2007).

This addendum to the previously submitted Section 106 report (SRB&A 2006) includes the results and discussion of radiocarbon dating based on 11 samples collected from seven house pits during the 2006 field season that were processed in 2007 (Beta Analytic Radiocarbon Dating Laboratory [Beta Analytic] 2007) and were unavailable at the time of the 2006 report.

METHODOLOGY

Survey and Sampling Methodology

SRB&A surveyed the Housing and Airstrip Facility (HAF), the Mine Access Road and Coal Transport Conveyor, and the LLD between May and October of 2006. In mid-May, SRB&A conducted a reconnaissance field survey to identify cultural resources in the LLD area that consisted primarily of visual examination of the ground surface and bluffs along Cook Inlet. While snow cover was minimal at the time of the survey, the soil was still frozen below one or two inches depth, which prevented the survey crew from excavating test units.

During a survey in the LLD area in early July, SRB&A cleared underbrush, tested two house pit features located during the May survey, and surveyed portions of the south end of the mine access road and coal transport corridor. Following the discovery of the two house pits and numerous cache pits of several sizes during the May and July surveys, SRB&A devised and implemented a systematic, intensive survey plan that utilized a 20 meter grid uploaded into handheld Global Positioning System (GPS) units to guide field crews along the transect lines.

In September, SRB&A conducted surveys in the LLD area south of the Pan Am Logging Road that resulted in the documentation of 46 house pits (including the two discovered in May) and many smaller pits (Figure 2). These subsurface depressions ranged from three to 20 feet across. SRB&A cleared brush and flagged, mapped and measured most of the house pits (Table 1).

On a follow-up trip to survey a portion of the mine access road within the Ladd Landing area in October, SRB&A obtained 11 carbon samples from seven house pits, measured and mapped a group of house pits discovered at the end of September, and discovered two additional house pits previously obscured by vegetation. The discovery of these two house pits brought the total number of known house pits in the surveyed portion of the LLD area to 48.

SRB&A crewmembers excavated test units in several locations in the Ladd Landing area including in house pits (see blue triangles on Figure 3). Test units excavated in and near surface features contained evidence of human use in the form of fire cracked rock, wood ash, heat modified soils and charcoal. As described in the 2006 report, test units excavated within house pits but outside the central hearth areas of the main rooms yielded little evidence of human use except for buried surface horizons, or soil layers that indicate the location of the historic house floor. Artifacts found during tests of the hearth areas included slate flakes where the material had separated along its planes, some small pressure flakes of an opaque white vitreous material, and one square iron nail. The hearths also included burned bone, a variety of soil grain sizes and colors, and fire cracked rock consisting of both non-local volcanic cobbles and basal gravels. The volcanic rock included a number of consistently sized, rounded cobbles with vesicular cortex aligned in a semicircle in HP011 (see SRB&A 2006:Appendix C, Photograph C-33).

Based on discussions between SRB&A and the Alaska Department of Natural Resources, Office of History and Archaeology (ADNR, OHA) following the 2006 field season, ADNR, OHA assigned 16 Alaska Heritage Resources Survey (AHRS) numbers to the 48 house pits with house pits less than 50 meters apart clustered under one AHRS number. Figures 2 and 3 depict these house pits and clusters of house pits with their associated AHRS numbers.

Radiocarbon Dating

Radiocarbon dating is used to obtain age estimates on organic materials in archaeological contexts. Radioactive carbon (^{14}C) is produced when nitrogen 14 is bombarded by cosmic rays in the atmosphere and drifts down to earth where it is absorbed from the air by plants. Animals eat the plants and take ^{14}C into their bodies. Humans in turn take ^{14}C into their bodies by eating both plants and animals. When a living organism dies, it stops absorbing ^{14}C and the ^{14}C that is already in the object begins to decay at a slow but steady rate and reverts to nitrogen 14. The half-life of ^{14}C is 5,730 ±40 years in the Cambridge scheme; the earlier value devised by Willard Libby is 5,568 ±30, which is used when comparing dates with older data. In other words, half of the original amount of ^{14}C in organic matter will have disintegrated 5,730 ±40 years (or 5,568 ±30 per Libby) after the organisms' death; half of the remaining ^{14}C will have disintegrated after another 5,730 ±40 years (or 5,568 ±30 per Libby) years and so on. While the ^{14}C decays, the amount of the stable isotopes carbon-12 (^{12}C) and 13 (^{13}C) remain constant in the organic sample. By looking at the ratio of ^{12}C and ^{13}C to ^{14}C in the sample and comparing it to the ratio in a living organism or samples of known age, it is possible to determine the age of a formerly living thing. For example, if a tree was used as a part of a structure, the date that tree stopped living (when it was cut down) can be used to date the structure's probable construction date. Common materials used for radiocarbon dating include charcoal, wood, marine shell, organic human or animal bone collagen, and antler.

AMS (Accelerator Mass Spectrometry) radiocarbon dating is a way to obtain radiocarbon dates from samples that are smaller than those samples needed for standard radiocarbon dating. Standard dates require amounts of between one and 10 grams of charcoal, while AMS can use as little as one to two milligrams or 50 to 100 micrograms under special circumstances. As discussed above, in standard radiocarbon dating, scientists perform a limited or proportional count of the decaying ^{14}C atoms. But in AMS dating, researchers use an accelerator-based mass spectrometer to count all the carbon atoms, rather than just those atoms that are decaying. AMS dates are therefore more precise and require smaller samples.

SRB&A submitted 11 carbon samples to Beta Analytic Radiocarbon Dating Laboratory in Miami, Florida for dating (Table 1). These samples were then processed at the Beta Analytic Radiocarbon Dating Laboratory. Based on Beta Analytic's recommendation and to insure the best possible results, SRB&A requested that dates for the 11 samples be obtained using AMS.

All samples were pretreated by Beta Analytic to eliminate secondary carbon components using an "acid/alkali/acid" method. Secondary carbon components could result in a date that is either too young or too old. This method is commonly applied to charcoal, wood, peat, some sediments, and textiles. In this method, the sample is first crushed and dispersed in deionized water. The sample is then given acid washes to eliminate carbonates and alkali washes to remove secondary organic acids. Following the alkali wash, the sample is given a final acid rinse to neutralize the solution prior to drying. Contaminants such as associated sediments and rootlets were eliminated during these rinses. As all dates were obtained using AMS, all carbon samples were reduced to graphite. The graphite was then detected for ^{14}C content in the AMS.

The conventional radiocarbon age, as shown in Table 1 and Figures 3, 4, and 5, is the result of applying carbon-13 and carbon 12 ($^{13}C/^{12}C$) corrections to the measured age. Ages are presented with the unit "BP" (or Before Present), which is defined as AD 1950. In one case (HP011), the age was reported as pMC (or "percent modern carbon"), which suggests that the organic material was still alive after the advent of thermo-nuclear weapons testing (post-1950). These ratios may have been influenced by the presence of coal and marine mammal fats used as food or fuel, and volcanic ash, which may increase the amount of available stable carbon isotopes in the sampled material (Taylor 1987).

RESULTS AND DISCUSSION

Table 1 includes a summary of radiocarbon samples and results. Figure 2 depicts the locations of house pits identified during the 2006 field season and their assigned AHRS numbers. Figure 3 depicts the location of house pits identified by SRB&A during the 2006 field season, the location of the sampled house pits, the results of radiocarbon dating for those house pits, and the proposed project component locations. Figure 4 depicts associations of radiocarbon dates for tested house pits by stratigraphic level. Soil stratigraphy is described in natural levels, where discrete deposits of layered soils and forest floor matter have accumulated due to natural and human causes. Each level is internally consistent in its composition based on soil color, granularity, and mineral or organic composition. Root mat and forest duff describe the composition of the surface, where inorganic soil components mix with organic material from growing plants. These levels are described in Table 1.

It should be noted that radiocarbon dates are a statement of probability and may vary as much as two standard deviations (SD), or a measure of how closely data in a certain collection are scattered above and below the mean, or date, given. If the SD is low, then the data are tightly clustered around the mean. Conversely, if the SD is high, then the data are more dispersed from the mean. The distance of the data from the mean is an indicator of accuracy. In the case of the radiocarbon dates obtained for the LLD, the SD is consistently ±40. As discussed above, radioactive decay is a random process that occurs at a predictable rate that is approximated by the half-life, or the time required for half of the material to decay. Contrasting the measures of radioactive carbon to the stable (non-radioactive) isotopes of carbon and taking into account differing amounts of radiocarbon available at different times in history allows the laboratory to make statements of statistical probability for the age of a sample. The most accurate statistical measure would include using two SD above and below the mean, or 95 percent of the possible values, while one standard deviation above and below the mean would be less accurate (68 percent of the possible values). For example, the radiocarbon date for HP003 is 150±40 BP, which using two SD (95 percent confidence interval) could be interpreted to be as old as 230 BP or as young as 70 BP with 150 BP being the mean or apex of the curve and therefore the most probable age. Using the same example of HP003 dated at 150±40 BP, the date of occupation could be interpreted using one SD (68 percent confidence interval) to be as old as 190 BP or as young as 110 BP with 150 BP being the mean or apex of the curve.

Because of the likelihood that these samples could be relatively young in radiocarbon years, the high precision AMS method was used to date them. As a result, the SD was consistently ±40 years with the exception of one sample that tested as modern (Sample HP011LVL1; see Table 1). Higher SD might have occurred if standard radiocarbon dating had been used. The majority of dates ranged from 200 to 250 BP, one date was older than 300 BP, two dates were between 100 and 150 BP, one date was at 50 BP, and one date was modern (Table 1). The modern sample was from a layer stratigraphically above the cultural deposit at the interface between the forest duff layer and the layer below, which consisted of a light gray silt or ash deposit that was culturally sterile. This culturally sterile gray layer likely represents a period after the structure had been abandoned. If the gray layer is volcanic ash, then it may correspond to one of several well-dated volcanic eruptions, quite possibly the 1912 Katmai eruption that deposited up to several feet of ash over thousands of miles, and may provide an alternative method of dating the deposit.

Figure 5 shows the overlap of radiocarbon date ranges in houses where two samples at different levels were taken. The date ranges are shown at one and two SD for each sample, with the two SD dates having a 95 percent probability of being accurate and the one SD dates having a 68 percent probability of being accurate. Where two samples of deposits appear to have some stratigraphic separation, such as in HP004, HP021, and HP038, the dates overlap, indicating a probability that there was one period of occupation for each house pit. HP004 has two levels (or distinctly colored and textured soil bands) with carbon sample dates that closely match despite being separated by five inches of silt, indicating soil disturbance or a rapid accumulation of silt in a short time through structure refurbishment or volcanic ash fall. HP038 has a similar degree of overlap when the dates are expanded to two SD, between 120 and 210 BP at two SD (dashed lines in Figure 5) and between 160 and 170 BP at one SD.

HP021 has two dates separated stratigraphically with an older date over a younger date; however, the overlap between the two differing dates at two SD ranges (95 percent confidence interval) from 230 to 310 BP and intersect at 270 BP at one SD (Table 1; Figure 5). The possible use of marine mammal fat as fuel for fires, the degree of frost-driven soil churning, and the possibility of contamination of the stratigraphic column by forest fire charcoal not associated with the occupation are all factors that may account for this inversion. Marine resources absorb carbon from the water at a different rate than terrestrial plants and animals absorb carbon from the atmospheric carbon reservoir. This difference makes marine resources appear 400 to 750 years older than contemporary land plants and animals (Taylor 1987). Forest fire charcoal could have been in the soil removed in the house pit's construction, then the fill used to bank up around the walls and on the roof as insulation or naturally churned by frost heave action. In this same category of effects, the age of the wood burned is calculated from when the tree expired; it may not have been collected for burning until much later, and in the case of driftwood may have floated for many years before being deposited on a beach where it could dry out enough to become firewood.

HP011 included a buried charcoal hearth layer dated to 50 ±40 BP and a decayed spruce pole from the interface of the surface root mat and level one that dated as less than 50 years old (Table 1). Historical sources indicate the site was abandoned by 1913; thus, the charcoal could have been deposited from 1820 to 1913 with 95 percent confidence that the date is accurate. Even the youngest date coupled with the historic information meets the 50-year age guideline for determining the eligibility of the structures for the NRHP. In terms of stratigraphic position, the upper sample came from a spruce pole that fell or was placed after the abandonment of the house. The charcoal in the sealed deposit is clearly man-made. The silt or ash that separates the decayed wood sample may be tephra from the Katmai eruption in 1912, which was widely deposited in significant volumes because of the powerful volcanic explosion.

All but one of the house pits may have been occupied between 100 and 310 BP. The dates fall into the range of when Ladd Landing was known to be occupied in the historic period during the nineteenth and early twentieth centuries. The area at the mouth of the Chuitna River was first noted by Russian Orthodox missionaries to be the site of a Dena'ina winter village in the late nineteenth (Znamenski 2003). The missionaries referred to it as Chubutna (also Chilikhna, Chuvitna) and occasionally stopped there en route to larger communities such as Tyonek. Father Ioann Bortnovskii makes mention of visiting the community in diaries for 1898-1903 and describes it as a small settlement seven miles from Tyonek (Znamenski 2003:209, 234, 324). Father Bortnovskii wrote "At Chubutnu only one Indian family lives permanently; the others come here to work for the Ladd Company [saltery]" (Townsend 1974:19). Chubutna, the northernmost of four large historic villages in the Tyonek area, survived into the first decade of the twentieth century when a measles epidemic killed many people here in 1913 (Fall 1981:406; Kari and Fall 2003:68). Two families, the Chuitts and the Chilligans, are associated with the site. DeLaguna (1975:139) stated that the village was "on an ancient site, *Ts'ui'tna*."

SUMMARY

Samples obtained from seven house pits that are contributing properties to the *Ch'u'itnu* Archaeological District (TYO-00132) generally date to between 100 and 300 BP (1650 to 1850 AD). The radiocarbon data are consistent with the historic record and most samples (six) date to between 200 to 250 BP in age, one dates to 310 BP, two date between 100 and 150 BP, one dates to 50 BP, and one is modern in age (Table 1; Figures 3, 4, and 5). SRB&A is currently planning to return to the LLD area to more precisely map the house and cache pits and excavate additional test units in the house pits during the 2007 field season.

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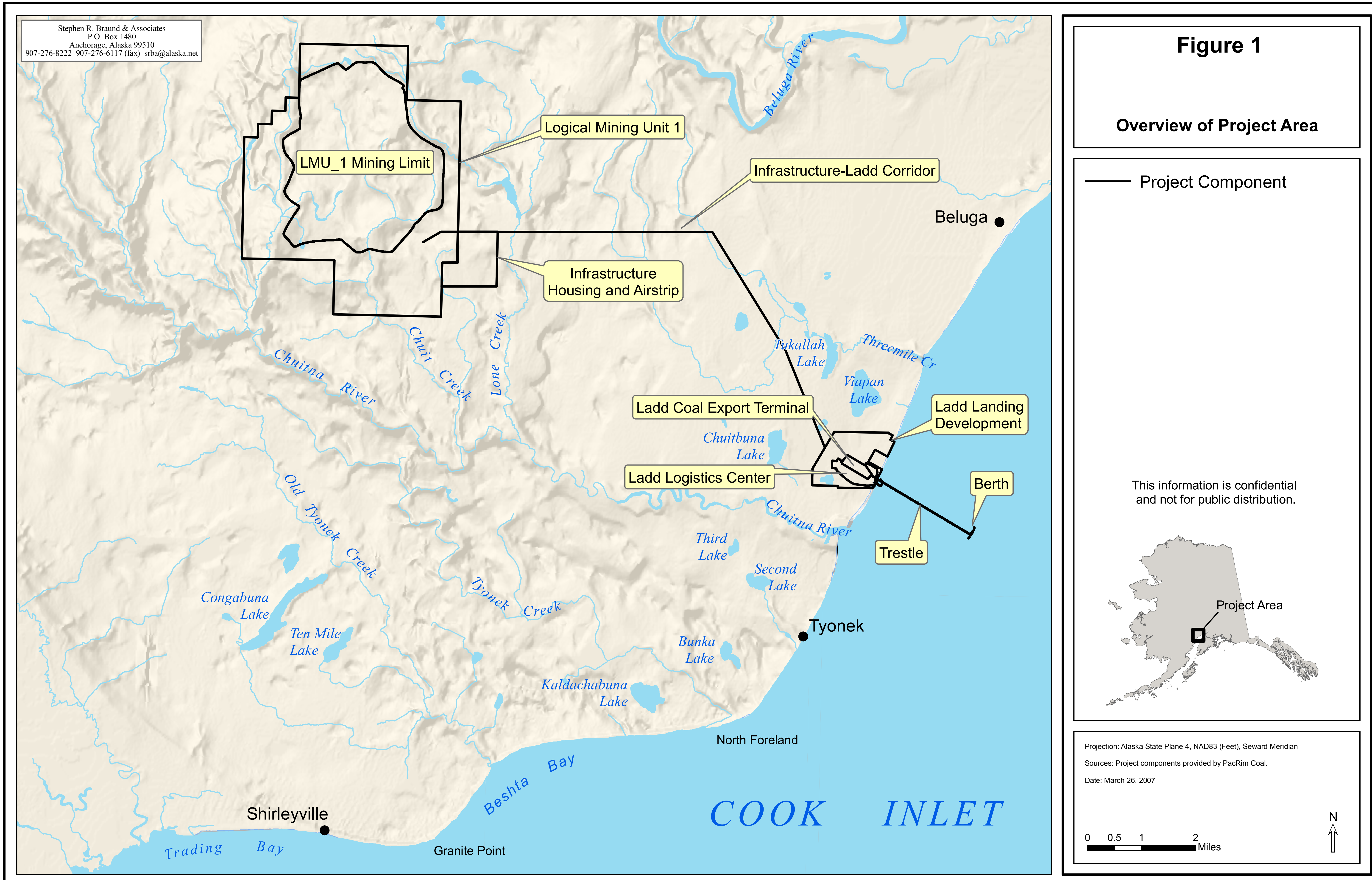

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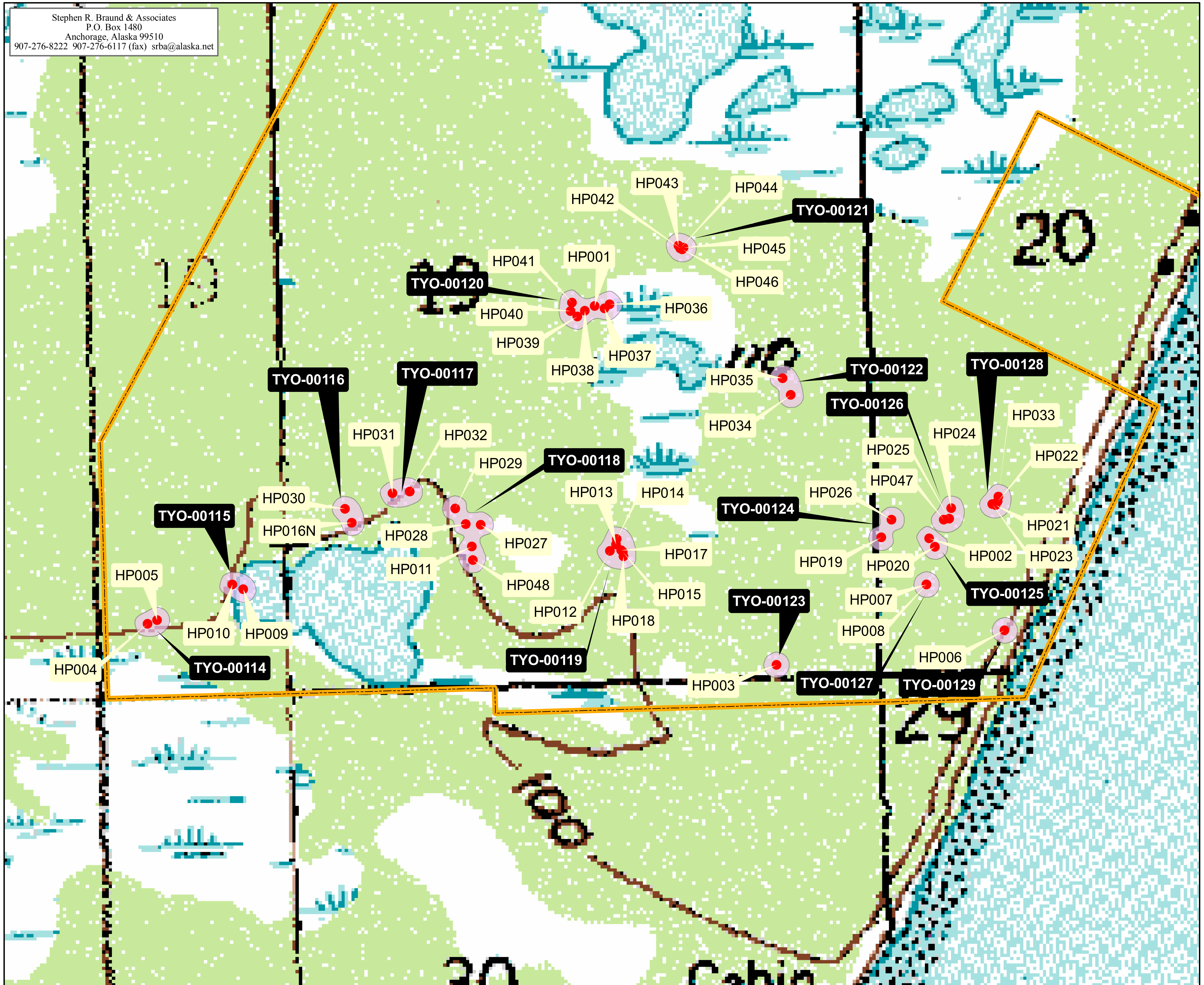

Figure 2

Overview of House Pits in the Ladd Landing Survey Development Area

House Pit

AHRS Site

Ladd Landing Development Survey Area

Stephen R. Braund & Associates, in consultation with the Office of History and Archaeology, assigned the 48 house pits shown to 16 Alaska Heritage Resources Survey (AHRS) sites (TYO-00114 to TYO-00129). In areas where pit locations were less than 50 m apart, AHRS sites designate clusters instead of single house pits. The AHRS site areas displayed on the map are smoothed 25 m buffers of all house pits assigned to an AHRS site.

This information is confidential and not for public distribution.

Projection: UTM zone 5N, NAD 1927

Data Sources: House pit locations identified by SRB&A during 2006 fieldwork.

Basemap: USGS 1:63,360 Tyonek A3 and A4 quadrangles.

Figure Date: March 26, 2007

0 375 750 1,500 Feet

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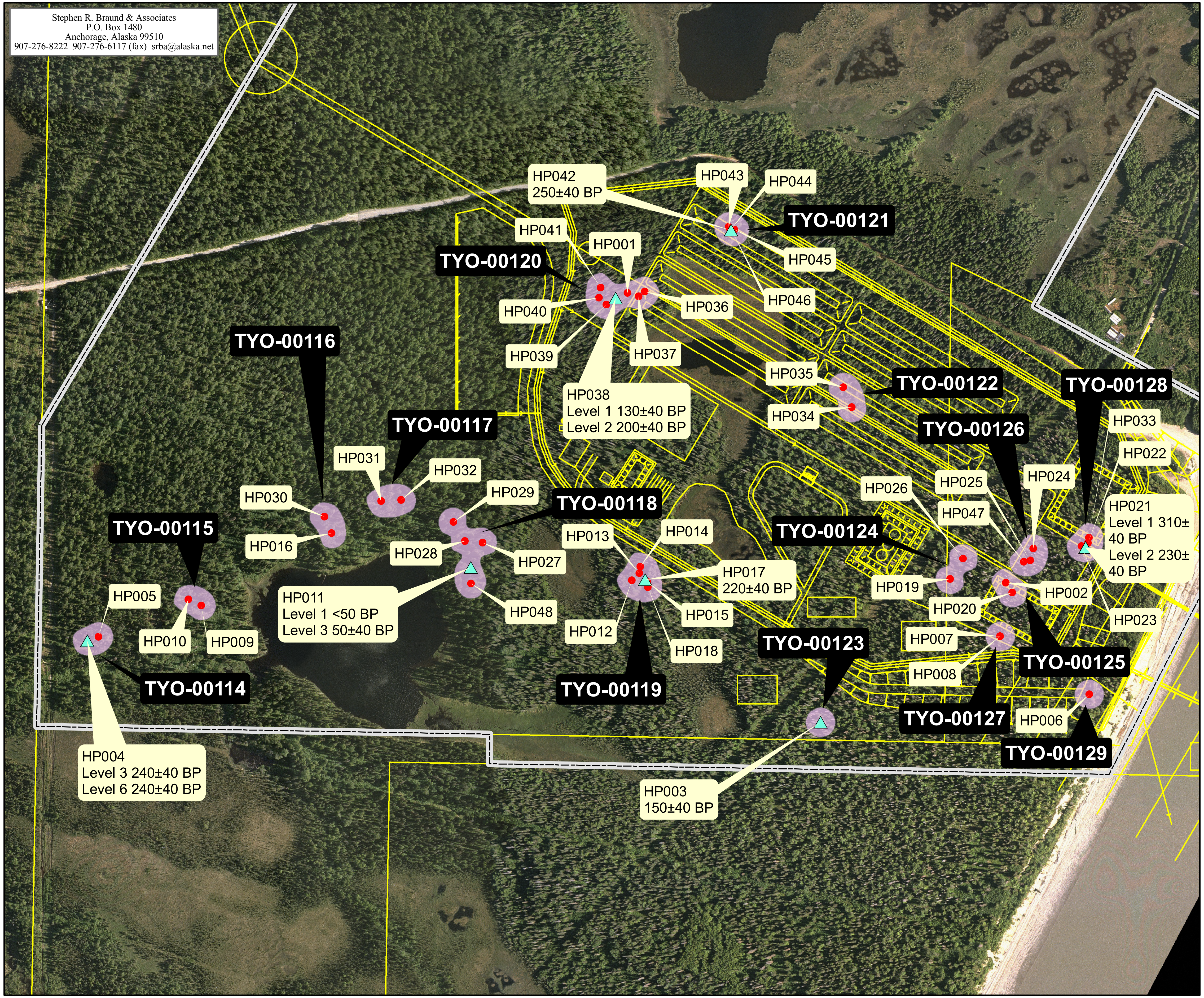

Figure 3

Locations of House Pits and Radiocarbon Samples

- House Pit
- House Pit with Recovered C14 Sample*
- AHRS Site
- Ladd Landing Development Survey Area
- Proposed Ladd Landing Development Subcomponent

*See Table 1 for radiocarbon test information.

Stephen R. Braund & Associates, in consultation with the Office of History and Archaeology, assigned the 48 house pits shown to 16 Alaska Heritage Resources Survey (AHRS) sites (TYO-00114 to TYO-00129). In areas where pit locations were less than 50 m apart, AHRS sites designate clusters instead of single house pits. The AHRS site areas displayed on the map are smoothed 25 m buffers of all house pits assigned to an AHRS site.

This information is confidential and not for public distribution.

Projection: Alaska State Plane 4, NAD83 (Feet), Seward Meridian

Data Sources: House pit locations identified by SRB&A during 2006 fieldwork. Aerial photograph and project components provided by PacRim Coal.

Figure Date: March 26, 2007

0 250 500 1,000 Feet

N

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Figure 4: Stratigraphic Associations of Radiocarbon Dates

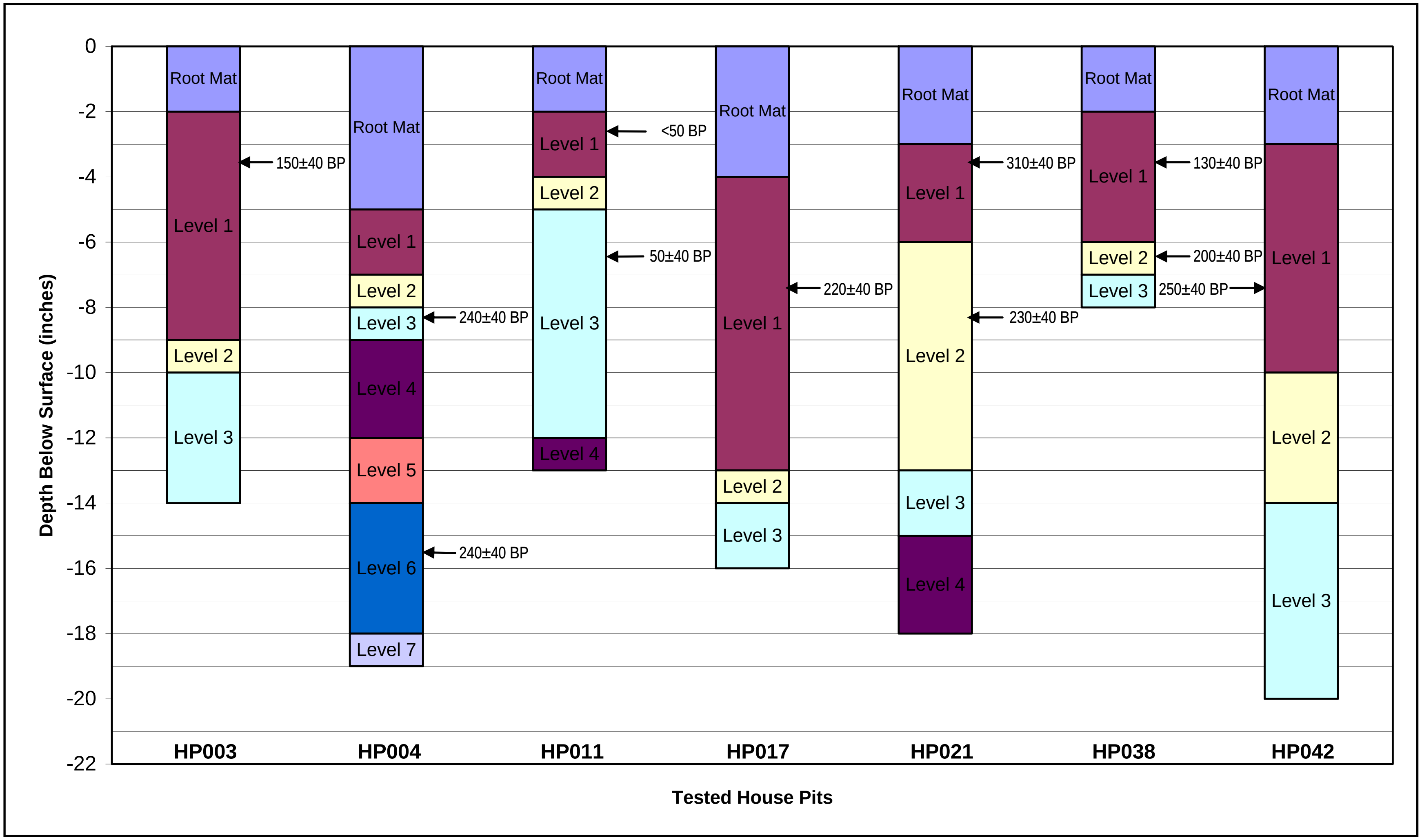

Figure 5: Radiocarbon Date Ranges and Overlap for Sampled Units

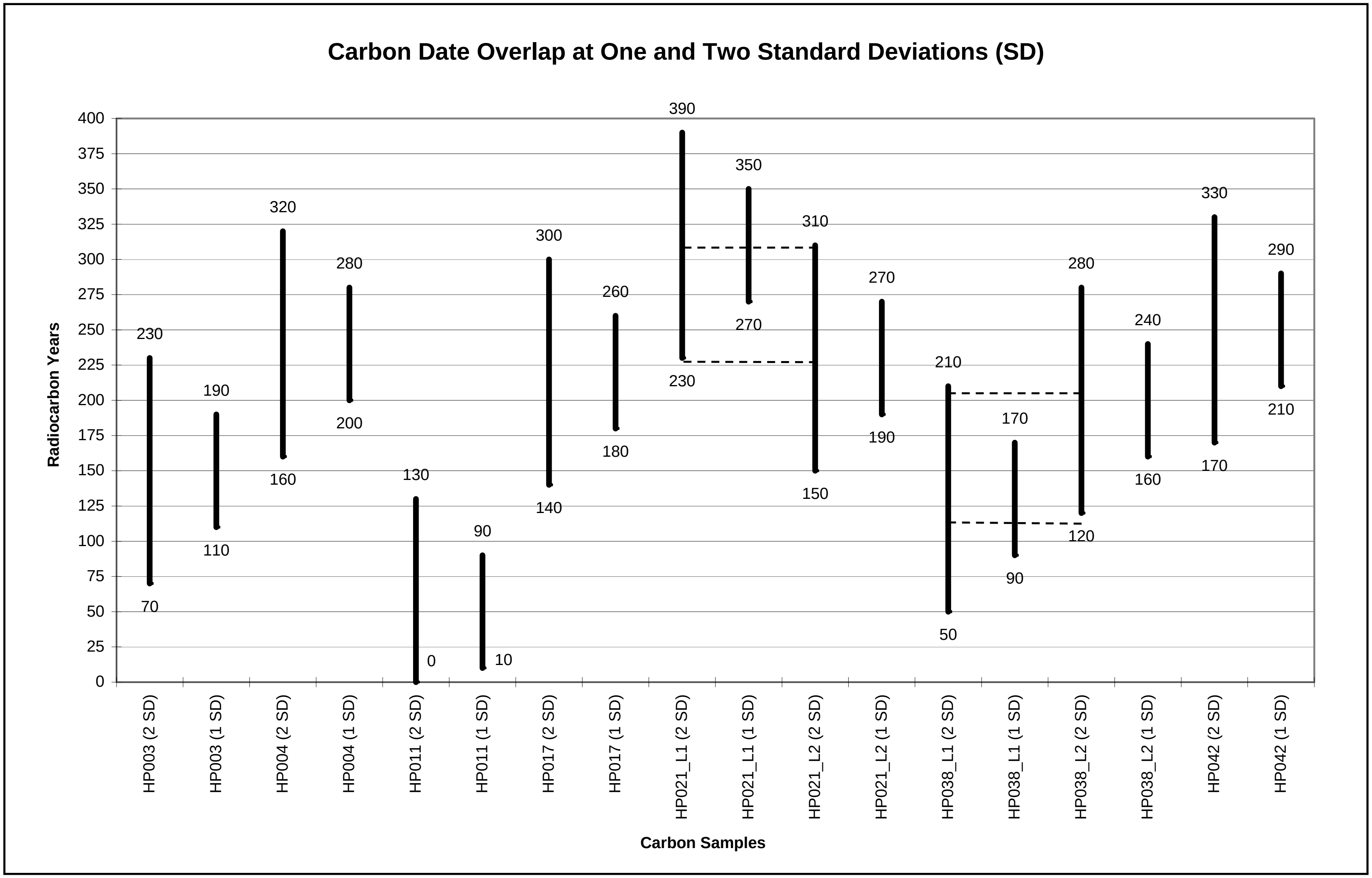

Table 1: Summary of Results of Radiocarbon Dating

Beta #	Sample #	Test Unit #	House Pit #	House Pit Size (ft)	Level	Level Description	Latitude Decimal Degrees	Longitude Decimal Degrees	Elevation (feet)	Analysis	Material	Pre-Treatment	Measured Radiocarbon Age	13C/12C Ratio	Conventional Radiocarbon Age
225046	HP003LVL1	HP003	3	35x23.5 (2 room, tunnel)	1	Tan silt, calcined bone, fire cracked rock, charcoal	61.1088	-151.10958	69	AMS	charred material	acid/alkali/acid	160±40 BP	-25.5 o/oo	150±40 BP
225047	HP004LVL3	TL002	4	27x17 (1 room, tunnel)	3	Tan silt	61.1098	-151.13245	112	AMS	charred material	acid/alkali/acid	250±40 BP	-25.6 o/oo	240±40 BP
225048	HP004LVL6	TL002	4	27x17 (1 room, tunnel)	6	No description	61.1098	-151.13245	112	AMS	charred material	acid/alkali/acid	240±40 BP	-25.1 o/oo	240±40 BP
225049	HP011LVL1	HP011	11	31x23 (2 room)	1	Blackened log	61.111	-151.12055	112	AMS	wood	acid/alkali/acid	100.4±0.5pMC [1]	-25.2 o/oo	100.4±0.5 pMC[1]
225050	HP011LVL3	HP011	11	31x23 (2 room)	3	Red/orange silt with charcoal	61.111	-151.12055	112	AMS	charred material	acid/alkali/acid	40±40 BP	-24.3 o/oo	50±40 BP
225051	HP017LVL1	HP017	17	26x51 (3 room)	1	Brown silt with charcoal, bone fragments, pockets of orange silt	61.1109	-151.11512	102	AMS	charred material	acid/alkali/acid	220±40 BP	-24.7 o/oo	220±40 BP
225052	HP021LVL1	HP021	21	30x22 (2 room, tunnel)	1	Dark black soil and decayed organics	61.1115	-151.10142	112	AMS	charred material	acid/alkali/acid	300±40 BP	-24.5 o/oo	310±40 BP
225053	HP021LVL2	HP021	21	30x22 (2 room, tunnel)	2	Gray/brown silt with pockets of charcoal	61.1115	-151.10142	112	AMS	charred material	acid/alkali/acid	180±40 BP	-21.8 o/oo	230±40 BP
225054	HP038LVL1	HP038	38	29x22 (2 room, tunnel)	1	Brown silt with charcoal, bone fragments, small pebbles	61.1151	-151.11618	89	AMS	charred material	acid/alkali/acid	140±40 BP	-25.7 o/oo	130±40 BP
225055	HP038LVL2	HP038	38	29x22 (2 room, tunnel)	2	Charcoal	61.1151	-151.11618	89	AMS	charred material	acid/alkali/acid	210±40 BP	-25.7 o/oo	200±40 BP
225056	HP042LVL1	HP042	42	19 x 18 (1 room)	1	Olive/tan silt, fire cracked rock, charcoal, small flakes	61.1162	-151.11263	102	AMS	charred material	acid/alkali/acid	250±40 BP	-25.0 o/oo	250±40 BP

[1] Reported result indicates an age after 0 BP and has been reported as a % of the modern reference standard indicating the material was living within the last 50 years

Sources: Beta Analytic 2007, SRB&A 2006

Stephen R. Braund & Associates, 2007.